**Activity: Counting particles by mass and converting to Moles**

Course: SCH3U

Unit: Quantities in Chemical Reactions

Lesson: Introducing the counting particles by mass, the mole concept and “chemistry language”

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| **BIG IDEAS**: | **MATERIALS**: |
| Particles can be counted if the mass of the sample is known. The mole, a unit of measurement, is a new concept and language that chemist’s use for calculating quantities in chemical reactions. | Skittles, jellybeans, balance, cup/beaker, mole worksheet |
| **MINISTRY EXPECTATIONS**: |
| **Specific expectations:**  **D2.3** solve problems related to quantities in chemical reactions by performing calculations involving quantities in moles, number of particles, and atomic mass  **D3.2** describe the relationship between Avogadro’s number, the mole concept, and the molar mass of any given substance |
| **STUDENT LEARNING GOALS**: | **APPENDICES** |
| 1. Students can see that the number of particles within a sample can be calculated if the mass of the sample is known 2. Students understand the concept of a new measurement called the mole and are ready to start applying it in mole calculations |  |
| **PRIOR KNOWLEDGE:** |
| * Calculating using exponents * Solid use of a scientific calculator |

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| **Grade 11 Chemistry, Academic (SCH3U) Quantities in Chemical Reactions: *Counting particles by mass and converting to moles*** |  |
| **Minds On – 15 minutes** | **Connections** |
| **Whole class ⇒ Introduction to relative mass**   * Introduce the concept of relative mass by explanation using balls * Use relative mass to explain relative atomic mass |  |
| **Action – 30 minutes** |  |
| **Whole class ⇒ counting particles by mass**   * Have the balance, jellybeans and skittles prepared for the class * Give them the handout and read the introduction together * Get the students into pairs and let them complete the weighing activity * Introduce the concept of the mole using the jellybeans and skittles * Complete the activity after introducing mole and Avogadro’s number | AfL: check for understanding of concept by having the students answer questions after the activity |
| **Consolidation and Connection – 25 minutes** |  |
| Complete sample problems of the mole |  |

**Activity Overview & Teaching Notes**

* This is a **3-40 min activity** that is meant to serve as an introduction to a new chemistry language of the mole
* This activity also helps students understand that the number of particles found within a sample can be counted if the mass of the sample is known. The students will experiment with this by using skittles and jellybeans, which are different sizes and masses.
* The mole is a common misconception that students seem to have when it is first introduced so this activity has been designed for students to grasp a solid understanding about what it is.
* Having a hands on activity where students can physically weigh out there “particles” and using math to figure out their “unknown samples” aid helps students grasp this concept
* Having student first design their own ‘new unit of measurement’ and do sample problems in relation to it will help that understand that the mole is the exact same thing, just much larger.
* Students can do this in pairs or they can do it on their own. It is a simple enough task that they could carry out on their own.

**Chemistry activity: Counting particles by mass and converting to Moles**

Chemists are not able to see individual atoms, yet they know how many particles, molecules and ions make up these atoms. How do they know how many particles make up a carbon atom? They are able to use the mass of the sample to find out how many particles make up the sample. In this activity you will use the mass of a sample of jellybeans and skittles to determine how many pieces you had in the random sample.

**Materials you need:**

250mL beaker

jellybeans

skittles

balance

**Instructions:**

1. Weigh a clean, dry beaker on the balance and record the mass of the balance in the flowchart below
2. Count out 10 jellybeans and place them in the beaker and weigh them. Record the mass of the jellybeans in the flowchart
3. Calculate the average mass of **one** jellybean and record in the flowchart
4. Take a random handful of jellybeans without counting them out and weigh and record the mass
5. Using the average mass of one, calculate how many jellybeans you had in your handful
6. Now count your jellybeans and see if your calculations match
7. Repeat these steps using skittles instead

*Determining the number of* ***jellybeans*** *in an unknown sample:*

Mass of handful of jellybeans:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Average mass of 1 jellybean:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of 10 jellybeans:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of beaker:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of jellybeans in the handful:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Determining the number of* ***skittles*** *in an unknown sample:*

Mass of handful of skittles:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Average mass of 1 skittles:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of 10 skittles:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of beaker:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of skittles in the handful:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

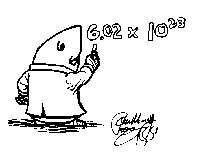
**Questions to be answered:**

1. When you estimated the number of jellybeans or skittles in your random handful, after doing the calculations, did the numbers match up/were they close?
2. Now that you have the mass of one jellybean, calculate the expected mass of you were to have 15 jellybeans and 15 skittles:

**Mass of 15 jellybeans: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Mass of 15 skittles: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. How are these masses the same and how are they different? Explain your answer.
2. Why did you go about determining the average mass of one jellybean instead of measuring out the mass of one jellybean right away?

**Introduction to the “Mole”**

The ‘mole’, in chemical terms, is a unit of measurement used to describe the number of particles found within a substance. There are many examples of units of measurement such as a ***dozen*** of eggs, a ***pair*** of shoes etc. This activity will help you understand a new unit of measurement called a ***mole***. The amount of items found in one mole is 6.02 x 1023 items (602,000,000,000,000,000,000,000 items!!!!). Let’s come up with our own “new unit of measurement”, this should help you understand the concept of the mole.

1. Obtain 4 jellybeans. We will call this number of jellybeans a  ***HAMSTER*** of jellybeans.

**Questions:**

A  ***HAMSTER*** of oranges will have \_\_\_\_\_\_\_\_\_\_\_\_ oranges

A  ***HAMSTER***  of grapes will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ grapes

A  ***HAMSTER***  of skittles will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ skittles

A  ***HAMSTER***  of molecules of water will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules of water

A  ***HAMSTER***  of atoms of oxygen will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ atoms of oxygen

Now that you have an understanding of what a ***HAMSTER*** of items is, answer the following:

1. how many jellybeans are found in 2 ***HAMSTERS? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***
2. how many skittles are found in 10 ***HAMSTERS****? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*
3. how many chocolate bars are in 200 ***HAMSTERS***? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. how many candies are in 0.5 ***HAMSTERS*? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
5. how many balls are found in 3.5 ***HAMSTERS***? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

We just learnt that one ***HAMSTER*** is the unit of measurement of *anything* that contains 4 items.

In chemistry there is a unit of measurement call the ***mole***. A mole is the unit of measurement of *anything* that contains 6.02 x 1023 items (602,000,000,000,000,000,000,000 items). This number is known as ***Avogadro’s number***. Now lets do some more questions using the ***mole*** instead of the ***HAMSTER***.

**Questions:**

A  ***mole*** of oranges will have \_\_\_\_\_\_\_\_\_\_\_\_ oranges

A  ***mole***  of grapes will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ grapes

A  ***mole***  of skittles will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ skittles

A  ***mole***  of molecules of water will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules of water

A  ***mole***  of atoms of oxygen will have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ atoms of oxygen

Now that you have an understanding of what a ***mole*** of items is, answer the following:

1. how many jellybeans are found in 2 ***moles? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***
2. how many skittles are found in 10 ***moles****? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*
3. how many chocolate bars are in 200 ***moles***? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. how many candies are in 0.5 ***moles*? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
5. how many balls are found in 3.5 ***moles***? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Let’s do some conversion factors (Answer the best option and show your work)

**Remember**:  **OR**

1. Number of atoms in 0.500 mole of Al

a) 500 Al atoms

b) 6.02 x 1023 Al atoms

c) 3.01 x 1023 Alatoms

1. Number of moles of S in 1.8 x 1024 S atoms

a) 1.0 mole S atoms

b) 3.0 mole S atoms

c) 1.1 x 1048 mole S atoms

1. Why do you think it is important that chemists use this universal language for communicating quantities in chemical reactions?